Tecnews

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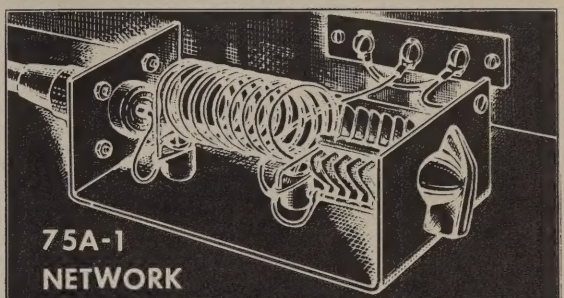
DECEMBER 1951

Matching networks for improving receiver signal-to-noise ratio.

By Clayton F. Bane, W6WB

A few years back there was a big flare-up in the amateur press on the subject of signal to-noise ratio in receivers. By Goodman's article in QST for September 1947 was really a classic on the subject, good enough in fact to have thoroughly aroused the amateur fraternity and to have made them fully conscious as to the importance of such measurements. It didn't though, possibly because many felt that such matters could be left in the hands of the engineers who designed the expensive communication receivers that they were using. To this, yes and no. Yes, because due consideration had very probably been given to this subject in the initial design of the receiver. No, because the user may not be operating the receiver in a manner that will take advantage of its full capabilities. We, and many others, have written about the importance of impedance matching between the receiver input and the transmission line, but most of us have been negligent in that we have stressed gain rather than signal-to-noise ratio. The noise referred to in this ratio is generated in the receiver and establishes the minimum level of the weakest signal that can be received. Maybe a simple test will be convincing. Set up the controls on your receiver as you normally would for average weak signal reception. Now, short the input terminals of the receiver and observe the noise level. The noise that remains, (assuming that the receiver has reasonable shielding and negligible external pickup) is in the receiver itself and represents the level of the weakest signal that can be copied on a one-to-one, signal-to-noise basis. (With the particular gain control setting that has been used for this test). If, under these circumstances, the remaining noise level is high, what does one do about it? Number one on the list of things to do is to make certain that the transmission line is properly matched to the receiver input.

Very few of the modern communications receivers have input circuits designed to match low impedance lines, (52-72 ohms) and mismatches as high as 10:1 are not uncommon. It shouldn't require any extensive proof to convince even the most sceptical that when a mismatch of this magnitude exists, maximum voltage will not be applied to the grid of the tube used in the first RF stage. This is



75A-1 NETWORK

FOR USE WITH 75A1 RECEIVERS WHERE 52 OHM CONCENTRIC LINES ARE EMPLOYED.

14 MCS. — Wound with #14 PE wire on 7/8" form. Diameter, (I.D.) should be 1" when removed from form. The coil should have 10 turns spaced to total length of 1-5/8". Variable capacitor is 100 mmf.

28 MCS. — Same as above except that it has 8 turns spaced to 1-1/4" Variable capacitor is 50 mmf.

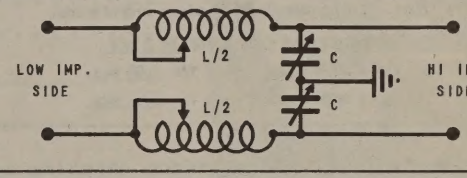
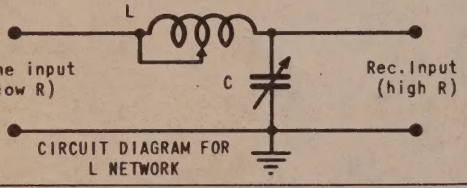


CHART FOR BALANCED "L" NETWORKS

Z		14 MCS.		28 MCS.	
LINE	REC.	L/2	C	L/2	C
300	50	.63	204	.315	102
"	100	.8	107	.4	58.5
"	600	1.7	37.8	.85	18.9
"	800	2.2	36.6	1.1	18.3
"	1000	2.6	34.6	1.3	17.3
"	1200	2.95	32.6	1.47	16.3
"	1400	3.25	31.0	1.62	15.0
"	1600	3.45	29.4	1.22	14.7
"	1800	3.8	28.2	1.9	14.1
"	2000	4.05	27.0	2.0	13.5

L in microhenries....C in micro-microfarads....Z in ohms.

not just a matter of gain...most receivers have more overall gain than can be used... but rather of "Noise-free" gain. The gain controls can be advanced to make a weak signal stronger but unfortunately the internal set noise increases by the same amount, i.e., the signal-to-internal set noise ratio remains constant and there is no increase in signal readibility.



CIRCUIT DIAGRAM FOR L NETWORK

DESIGN CONSTANTS FOR L NETWORKS

R-Line	R-Rec.	X_c	X_L	L	C
52	100	103.7	50	.56	108
"	200	116	87.6	.98	97.3
"	300	132	113.5	1.2	85.5
"	400	152	134.5	1.5	74.2
"	500	166	153.5	1.73	68
"	600	181.8	170	1.9	62
"	800	208	196	2.2	54
"	1000	232	222	2.5	48.6
"	1500	280.5	278	3.1	40.2
"	2000	324	318	3.5	34.7

L-C in above chart are for a frequency of 14.1 mcs.
R-X Ohms, L microhenries C micro-microfarads.

Divide both L and C by 2 for 28.2 mcs.
Multiply both L and C by 2 for 7.05 mcs.
Multiply both L and C by 4 for 3.52 mcs.

Line-to-receiver impedance matching by using external networks can be highly important because such matching can often result in a startling improvement in signal-to-noise ratio yet is a step that requires no tampering with the internal portions of the receiver. There is lots more to this story and we hope to take up the subject of noise generators as well as possible improvements in receiver SNR in an early issue. We have had so many requests for further design data on matching networks that we are devoting this issue entirely to this subject.

It is almost a hopeless task to undertake to design and tune a network unless the input impedance of the receiver is known. The "L" networks to be discussed exhibit relatively broad characteristics when an attempt is made to tune them on an aural basis and the situation is further complicated by the fact that both L and C must be adjusted in order to bring the network into exact tune. Methods described by this writer in TECNEWS for Oct., 1950, namely a co-ax bridge with a suitable driving source, make network tuneup a very simple matter. With this latter setup, it is only necessary to tune "C" through its range until a minimum SWR is obtained; this procedure being repeated using different values of L until unity SWR reading is obtained on the bridge. Step-by-step procedure was given in the previous article and will not be repeated. A word of caution however: THE RECEIVER FRONT END MUST BE RESISTIVE! In other words, it must be resonant at the frequency of the bridge driving source signal. This is no problem with receivers having an antenna trimmer that is tunable from the front panel since this trimmer can be adjusted for minimum SWR at any frequency. The front end of receivers having internal trimmers may or may not be resistive at the measuring frequency depending upon the tracking. (See previous article).

The basic theory of the L network will still apply even though the network is balanced with respect to ground. Thus the capacitive branch of the network will always be connected across the impedance, (line or antenna) having the highest value. The inductance must be placed in both sides of the line in order to preserve balance, the value of the individual inductances however being half that used for unbalanced networks. It is desirable to establish a mid-point ground on the network therefore the capacitive arm is made up from two capacitors, (each with twice the capacity used on unbalanced networks) connected in series with the mid-point grounded. In practice, these two capacitors will conveniently be a split-stator with the rotor grounded. The column "2C" in the chart indicates the capacity of each section of the split stator. It is significant to note that the individual sections of the split stator become quite low in capacity on 10 meters where high impedances are involved. Capacitors with low minimum values must be used since the stray input capacity of the receiver will cause the net capacity of the split stator to be even lower than the values shown on the chart. There are only a few cautions to be observed in tuning the balanced networks. First, changes in inductance must necessarily apply to both coils. It is conventional practice to start with inductances higher in value than those shown on the chart and short out or remove turns until some setting of the capacitor will yield unity SWR. THE MID-POINT GROUND MUST BE REMOVED FROM THE SPLIT-STATOR WHEN ONE-SIDE-GROUNDED MEASURING INSTRUMENTS ARE CONNECTED TO ONE SIDE OF THE NETWORK! This will apply equally to bridges, Antennascopes, or to the Micromatch. The ground may be replaced after the tuning is completed. If the

(Continued on rear page)

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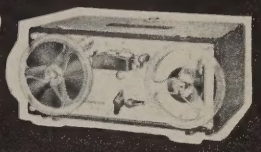

RECEIVERS

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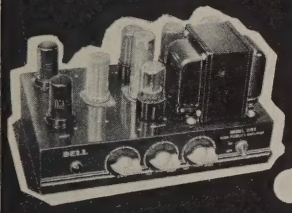

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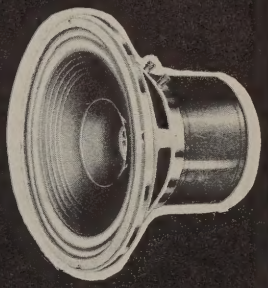

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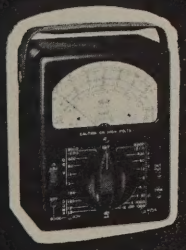

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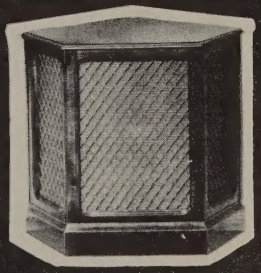

TEST EQUIPMENT

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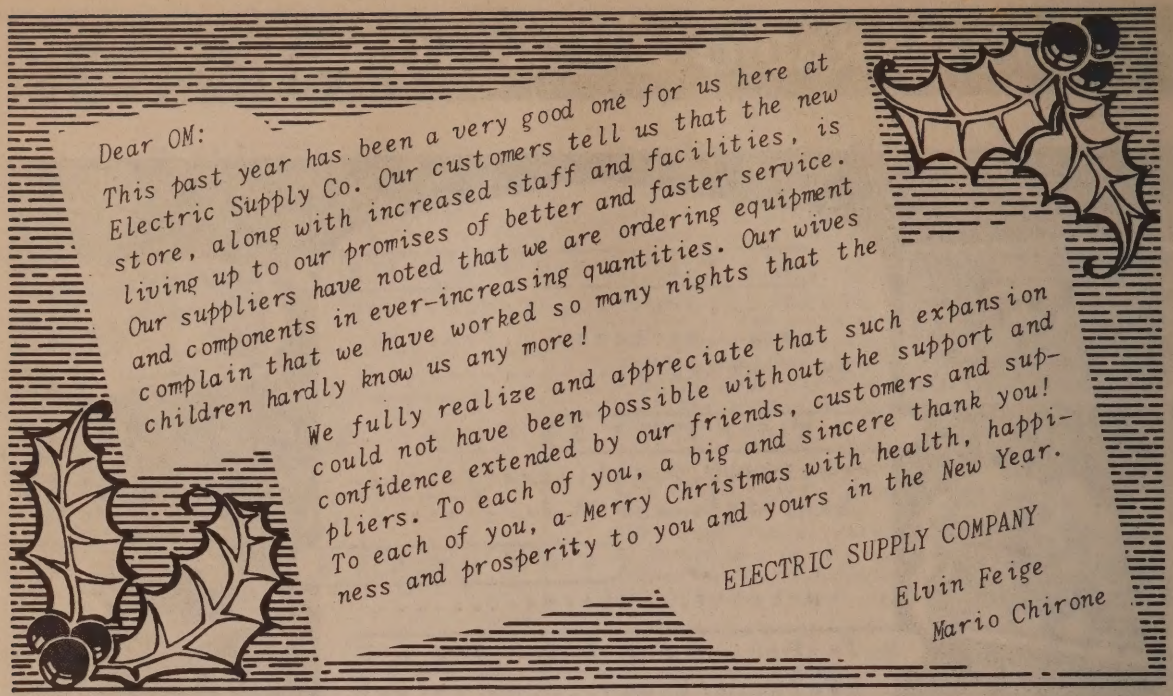
Dear OM:
This past year has been a very good one for us here at Electric Supply Co. Our customers tell us that the new store, along with increased staff and facilities, is living up to our promises of better and faster service. Our suppliers have noted that we are ordering equipment and components in ever-increasing quantities. Our wives complain that we have worked so many nights that the children hardly know us any more!
We fully realize and appreciate that such expansion could not have been possible without the support and confidence extended by our friends, customers and suppliers. To each of you, a big and sincere thank you!
To each of you, a Merry Christmas with health, happiness and prosperity to you and yours in the New Year.
ELECTRIC SUPPLY COMPANY
Elvin Feige
Mario Chirone

(Continued from inside page)

network is to be used with a 75A-1, take the 600 ohm chart value as a starting point for 14 mcs...the 1800 ohm values for 28 mcs. These approximate impedance values will apply whether the network is balanced or unbalanced.

Two typical networks are shown, (for 52 ohm lines) for the convenience of those who may not have suitable instruments on hand. Both are for 75A-1 receivers and, when made in accordance with specifications, may be tuned for maximum background response. The L networks have a limited bandwidth therefore it is important to tune them to a frequency that will permit the network to be effective over the most-used portion of a particular band. Generally speaking, the match will be good over a range extending approximately 200 kcs either side of the initial resonating frequency. 20 meter CW men should select 14,050 kcs....phone men, 14,250 kcs.

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